CONTENTS

Model Study of Narragansett Bay
Effects of Cooling Water Channel on Temperatures of Cooling Water at Narragansett Electric Company

Interim Report 4

Introduction

1. Interim Report 3 of August 1959 described the results of model tests made to determine the effects of the authorized Fox Point Barrier on water temperatures in the Providence River upstream from the structure, and especially at the Manchester St. and South St. intakes for condenser cooling water used by the Narragansett Electric Co. The results of those tests indicated that the barrier would cause significant increases in cooling water temperatures, especially at the Manchester St. intake.

2. The New England Division, CE, has explored various possibilities for incorporating into the design of the Fox Point Barrier some means for supplying the Narragansett Electric Co. with cooling water of at least the quality of that now available. It appeared that a satisfactory solution would obtain from construction of an access channel along the west side of the Providence River from the barrier to the existing intakes. A gate 40.0 ft wide by 15.0 ft high, with a sill elevation of -20.0 ft MSL, would be installed in the barrier to supply water to the channel, and the existing outfalls would be extended to discharge on the river side of a sheet pile wall separating the cooling water channel from the river. The details of the scheme are shown on plate 1, and the tests reported herein were made to determine the temperature of the intake water with the proposed scheme in operation, in relationship to that available under existing conditions.

Test Procedure

3. The width of the cooling water channel in the existing Narragansett Bay model was so small (0.06 to 0.08 ft) that it was considered possible that scale effects might produce unnatural flow conditions therein. To eliminate this possibility, the intake water for both generating stations was drawn directly from the location of the gate in the barrier which would provide water to the channel. Since the size of the cooling water channel is small in relationship to the quantity of water circulated, it is believed that the potential change in temperature of the water as it flows from the gate to the locations of the existing intakes is insignificant. For this reason, it is believed that the procedure used for the model tests yielded completely valid data as to intake water temperatures for plan conditions.

4. All other test techniques and procedures were in accordance with those described in Interim Report 3 of August 1959. Two identical model tests were conducted, and the results reported herein are averages of these identical tests.

Results

5. The scheme involving provision of the cooling water channel has been designated plan 3 for identification purposes, and the results of model tests of this plan are presented in tables 1 and 2 and on plates 2-6. The results of periodic measurements of minimum and maximum temperatures in the two intakes and at surface and bottom at stations B and G are shown on plates 2 and 3. The results of half-hourly measurements

of temperature over a complete tidal cycle at the time of temperature stability are shown on plates 4-6. These latter measurements were made in both intakes, at the surface above both intakes, and at surface and bottom at stations A, B, G, and 19.

6. The effects of the plan on minimum and maximum temperatures at all observation stations are summarized in table 1, and the effects on the average temperature over a tidal cycle at all stations are summarized in table 2. The last figures in table 2 show the effects of the plan on the average water temperature upstream from the barrier, as determined by inserting blocks into the channel at the end of the test, mixing the water quickly and thoroughly, then obtaining an average temperature measurement.

Discussion of Results

7. The results of the model tests of plan 3 indicate that all detrimental effects of the Fox Point Barrier on cooling water temperature would be eliminated by this plan. The average intake temperature at the Manchester St. station would be significantly lower than that for existing conditions, while the average temperature at the South St. intake would be no higher than for existing conditions. On an overall basis, the quality of the cooling water available to the Narragansett Electric Co. would be significantly better after completion of the barrier and the plan-3 cooling water channel than for existing conditions.

8. While not tested in the model, it is believed that the indicated improvement in water quality over existing conditions (as effected by plan-3) would be even more outstanding if the quantity of water

circulated should be increased as is contemplated. This opinion is based on the rather large reductions in average surface temperatures at the plan intake locations as compared to the existing intake locations (-4.4°F at the Manchester St. intake and -5.2°F at the South St. intake). If the quantity of water circulated should be increased appreciably, it appears that warmer water would be drawn into the intakes for existing conditions than for plan 3 conditions.

9. The results of the tests indicate that plan 3 would increase the average water temperature upstream from the barrier by about 3.4°F; however, this increase would be of little or no significance unless other plants obtain cooling water from the affected area.

TABLE 1

Effect of Cooling Water Channel on Temperature Extremes

Location	Extreme	Temperature Differences in Degrees Fahrenheit		
		Base Test*	Plan 3*	Effect of Plan 3
South St. Intake	Max.	-0.5	2.3	1.8
	Min.	-0.5	-1.6	-1.1
Manchester St. Intake	Max.	8.8	2.3	-6.5
	Min.	-0.5	-1.6	-1.1
Station B-Surface	Max.	10.8	11.5	0.7
	Min.	2.0	5.0	3.0
Bottom	Max.	-0.8	3.0	3.8
	Min.	-1.2	2.6	3.8
Station G-Surface	Max.	8.0	12.6	4.6
	Min.	1.0	2.0	1.0
Bottom	Max.	9.0	8.4	-0.6
	Min.	4.0	6.5	2.5
Station A-Surface	Max.	11.1	13.2	2.1
	Min.	2.8	3.8	1.0
Bottom	Max.	8.3	7.3	-1.0
	Min.	-0.2	6.3	6.5
Station 19-Surface	Max.	11.1	8.6	-2.5
	Min.	1.9	1.0	-0.9
Bottom	Max.	-1.0	-2.1	-1.1
	Min.	-1.2	-2.2	-1.0

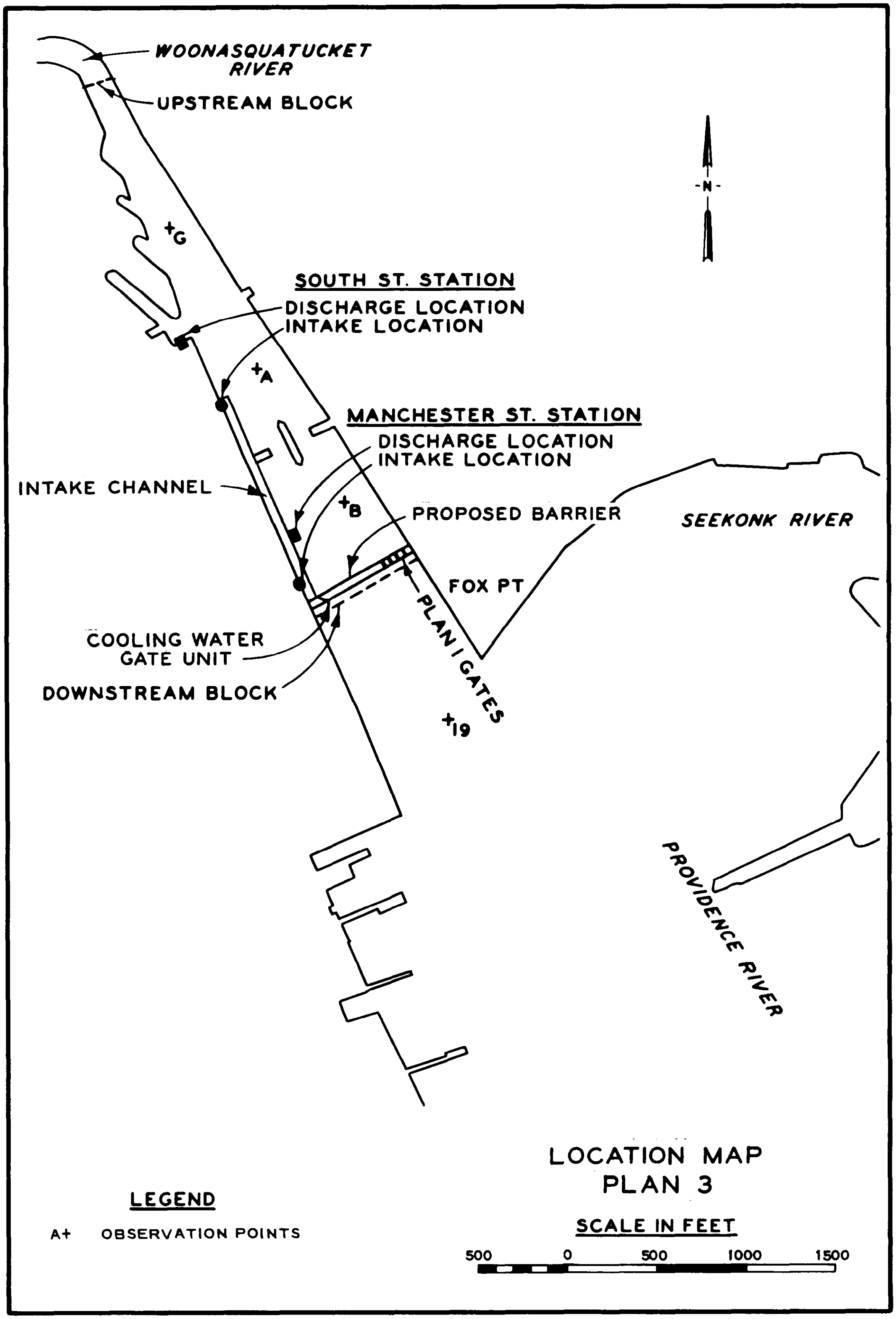
* Values are differences between the temperature at the observation point and the fresh-water temperatures and are averages of two identical model tests.

TABLE 2

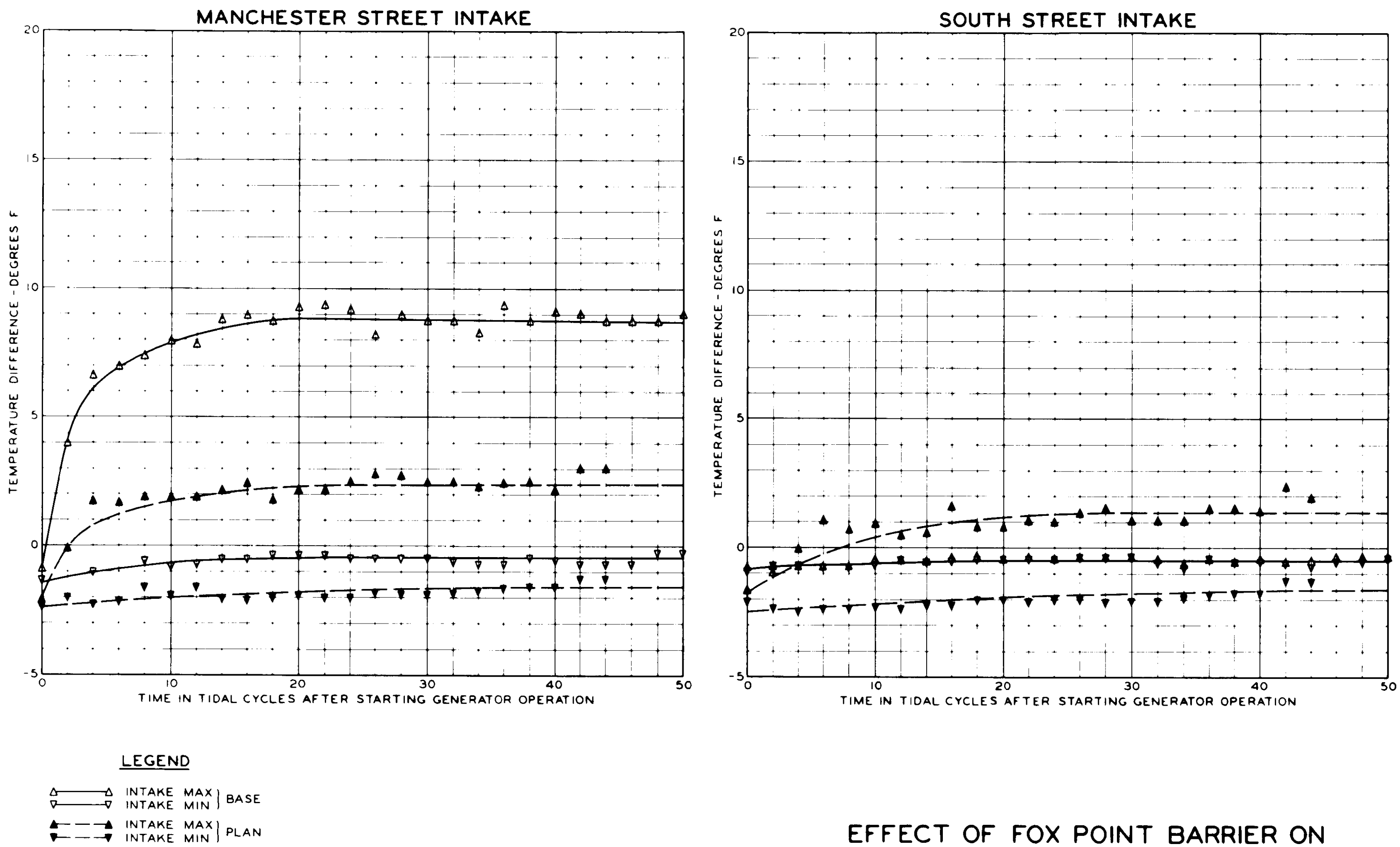
Effect of Cooling Water Channel on Average Temperatures

Location	Depth	Temperature Differences in Degrees Fahrenheit Base Test*	 Plan 3*	 Effect of Plan 3
Manchester St. Intake	Surface	6.8	2.4	-4.4
	Intake	2.1	-0.6	-2.7
South St. Intake	Surface	5.6	0.4	-5.2
	Intake	-0.5	-0.8	-0.3
Station A	Surface	6.9	9.9	3.0
	Bottom	1.8	6.8	5.0
Station B	Surface	7.8	9.3	1.5
	Bottom	-0.8	3.2	4.0
Station G	Surface	3.8	8.7	4.9
	Bottom	6.8	7.9	1.1
Station 19	Surface	7.1	4.4	-2.7
	Bottom	-1.1	-2.1	-1.0
Entire Area (after mixing at end of test)		4.2	7.6	3.4

* Values are differences between the temperature at the observation point and the fresh-water temperatures and are averages of two identical model tests.



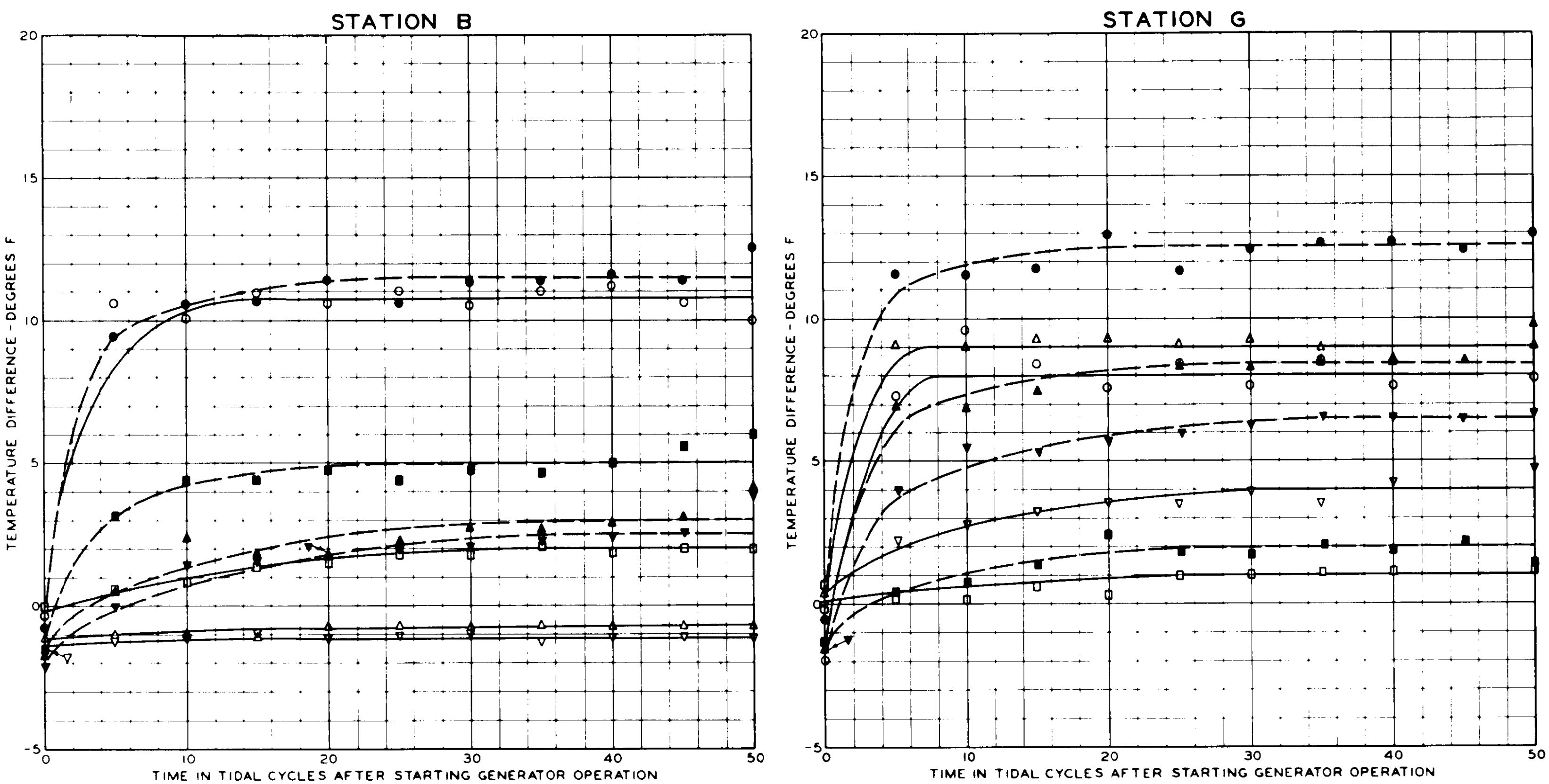
WOONASQUATUCKET RIVER
UPSTREAM BLOCK
-N-
SOUTH ST. STATION
DISCHARGE LOCATION
INTAKE LOCATION
G
A
MANCHESTER ST. STATION
DISCHARGE LOCATION
INTAKE LOCATION
INTAKE CHANNEL
B
PROPOSED BARRIER
SEEKONK RIVER
FOX PT
PLANIGATES
COOLING WATER GATE UNIT
DOWNSTREAM BLOCK
19
PROVIDENCE RIVER
LOCATION MAP
PLAN 3
LEGEND
A+ OBSERVATION POINTS
SCALE IN FEET
500 0 500 1000 1500



EFFECT OF FOX POINT BARRIER ON WATER TEMPERATURES

PLAN 3

MANCHESTER STREET AND SOUTH STREET INTAKES



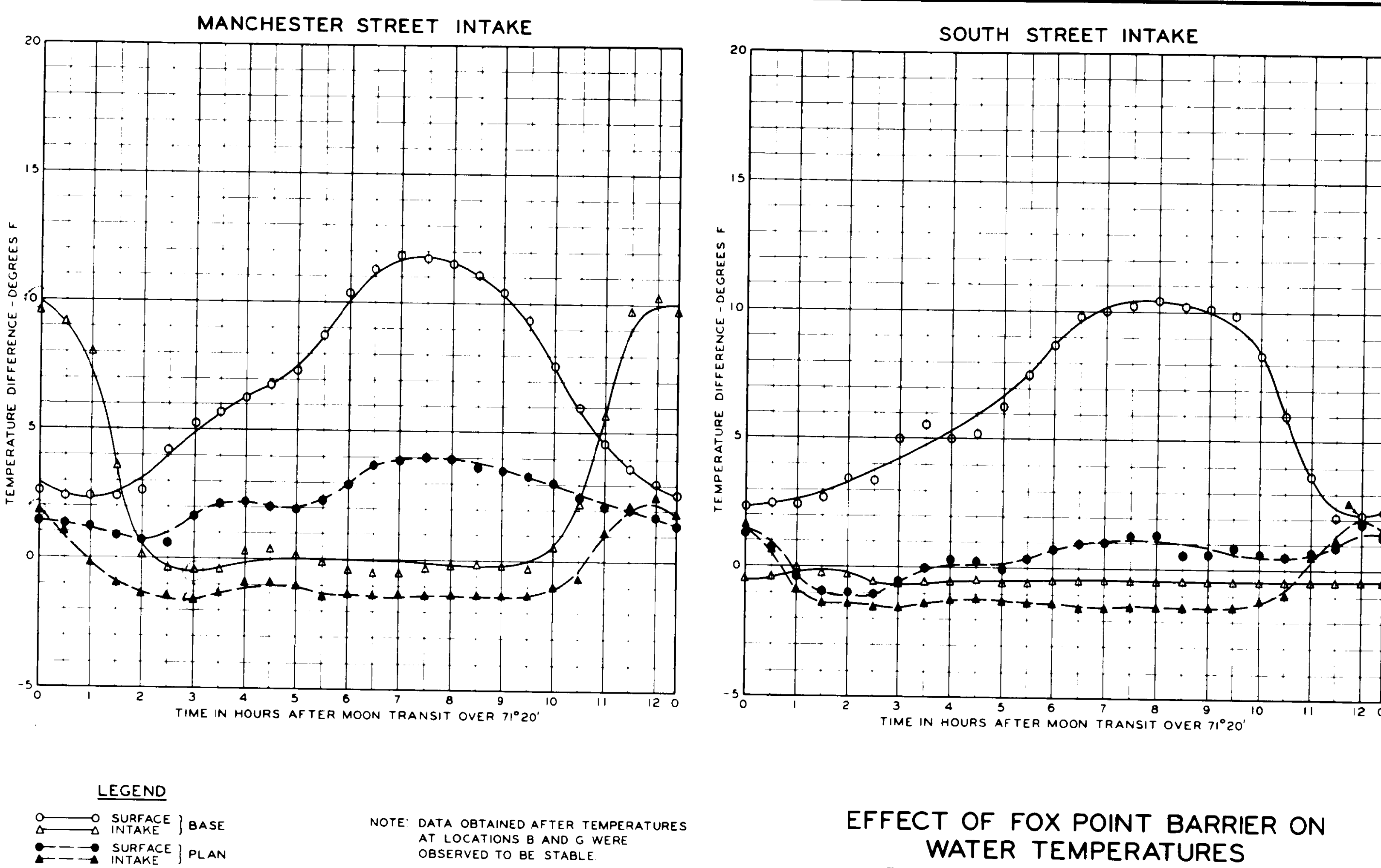
LEGEND

○———○	SURFACE MAX	BASE
□———□	SURFACE MIN	
△———△	BOTTOM MAX	
▽———▽	BOTTOM MIN	
●— — —●	SURFACE MAX	PLAN
■— — —■	SURFACE MIN	
▲— — —▲	BOTTOM MAX	
▼— — —▼	BOTTOM MIN	

EFFECT OF FOX POINT BARRIER ON WATER TEMPERATURES

PLAN 3

STATIONS B AND G

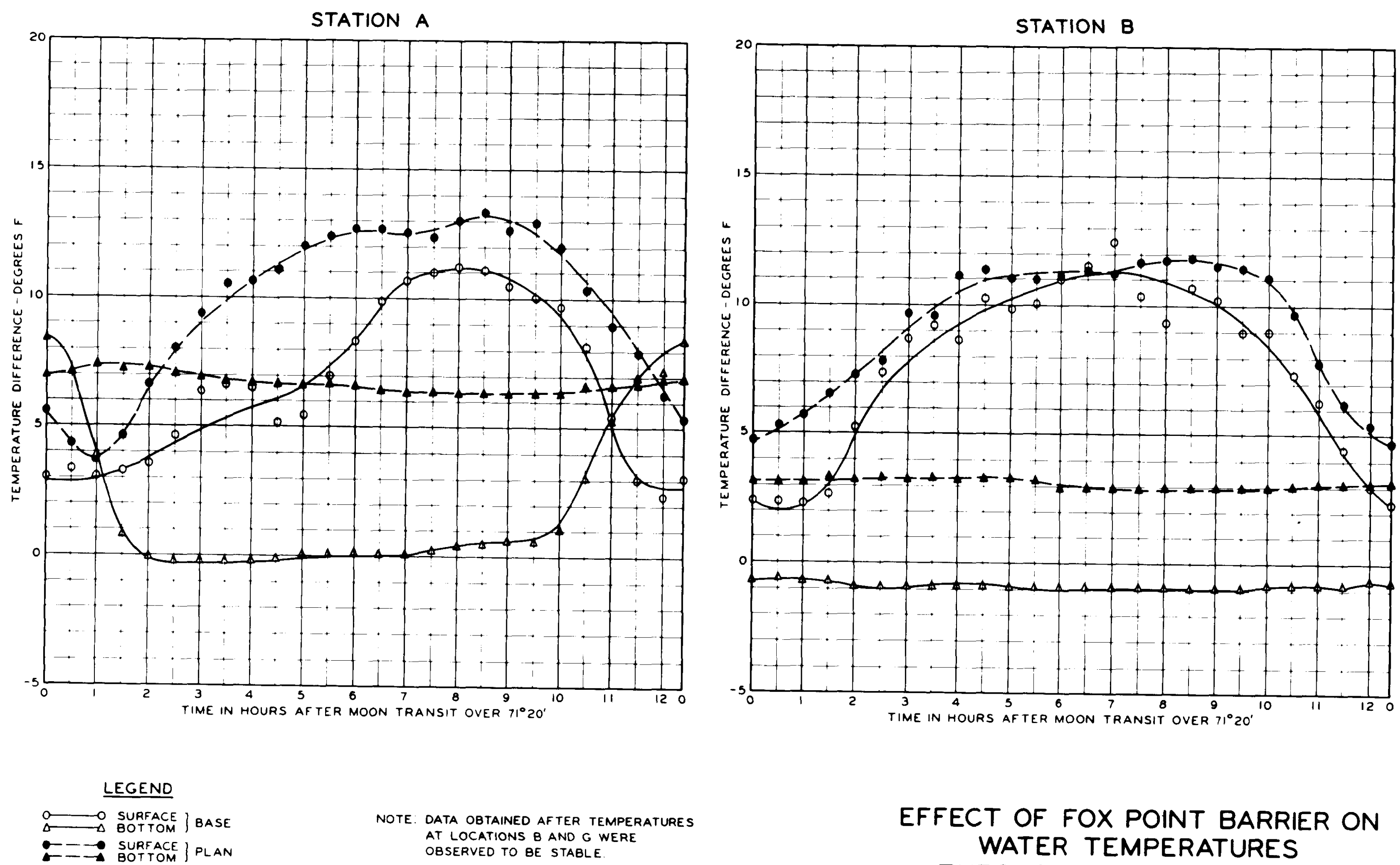


EFFECT OF FOX POINT BARRIER ON
WATER TEMPERATURES
THROUGHOUT A TIDAL CYCLE

PLAN 3

MANCHESTER STREET AND SOUTH STREET INTAKES

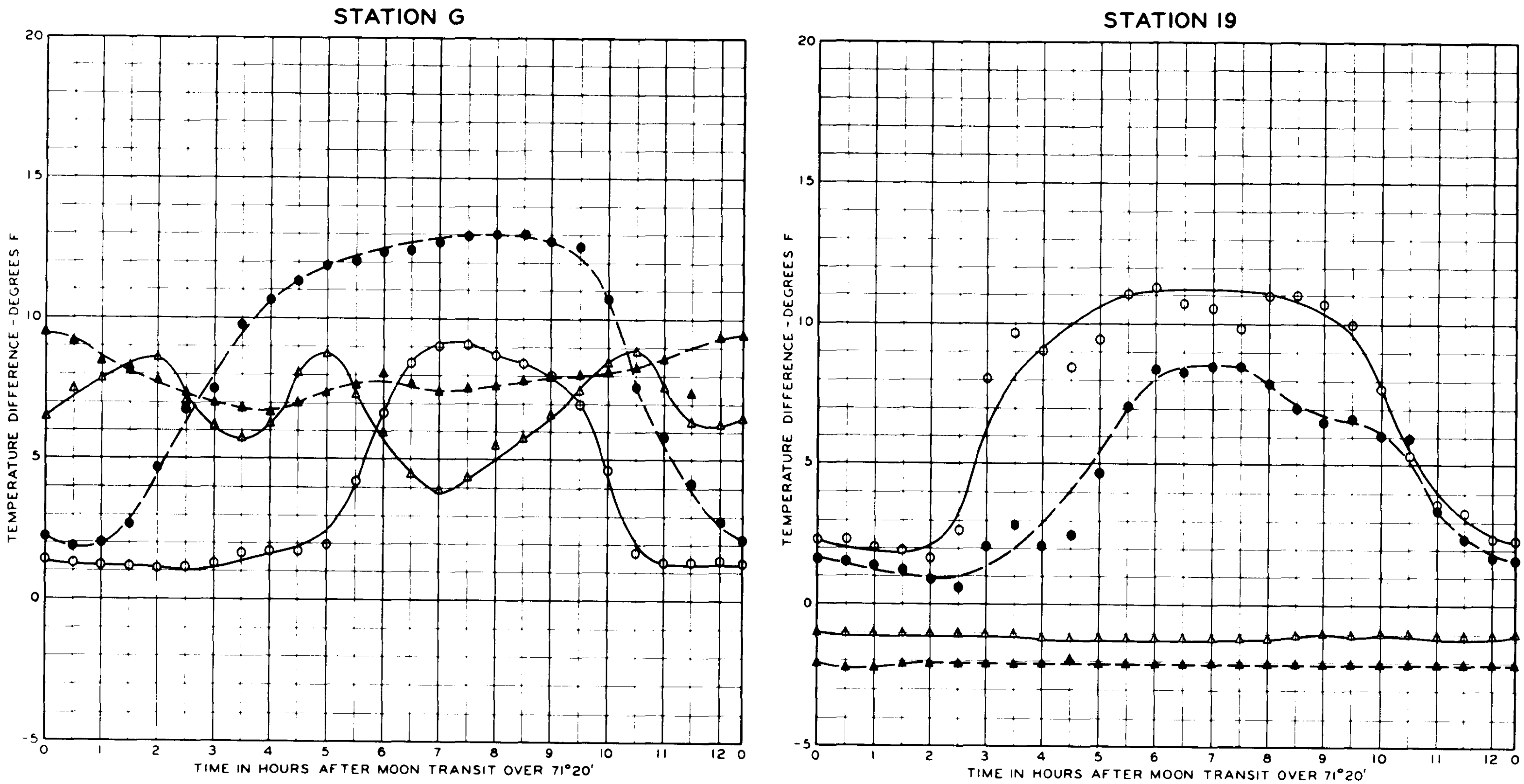
PLATE 4



EFFECT OF FOX POINT BARRIER ON WATER TEMPERATURES THROUGHOUT A TIDAL CYCLE

PLAN 3

STATIONS A AND B



LEGEND

SURFACE	} BASE	
BOTTOM		
SURFACE	} PLAN	
BOTTOM		

NOTE: DATA OBTAINED AFTER TEMPERATURES AT LOCATIONS B AND G WERE OBSERVED TO BE STABLE.

EFFECT OF FOX POINT BARRIER ON WATER TEMPERATURES THROUGHOUT A TIDAL CYCLE

PLAN 3

STATIONS G AND 19

PLATE 9